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(30)Priority

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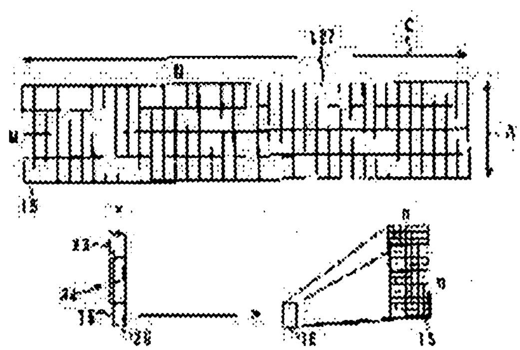
(54) RADIATION DETECTOR AND X-RAY CT DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a radiation detector realizing the matrix-like tiling of a large number of detecting elements.

SOLUTION: This radiation detector has a plurality of arrayed element blocks 15, and each element block has a plurality of radiation detecting elements formed as a matrix of m×n on a single substrate.



LEGAL STATUS

[Date of request for examination]

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[Patent number]

[Date of registration]

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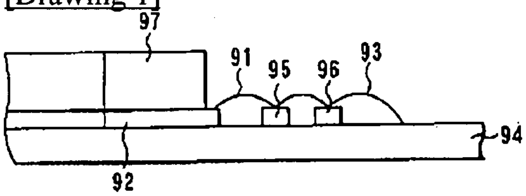
2.**** shows the word which can not be translated.

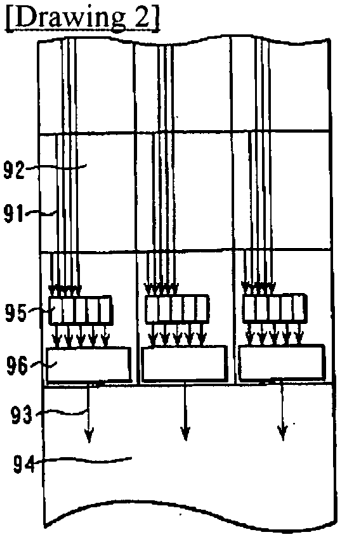
3.In the drawings, any words are not translated.

DRAWINGS

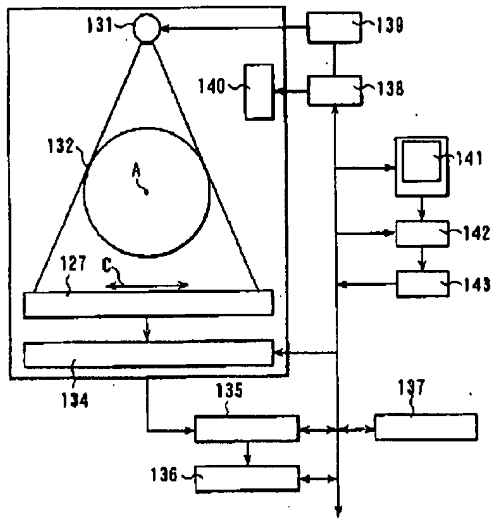
[Drawing 1]



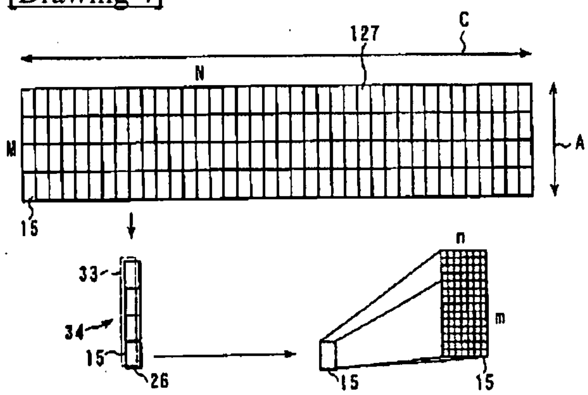
[Drawing 2]



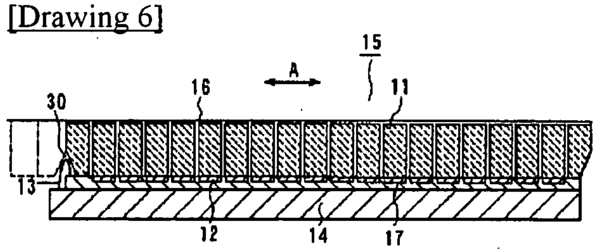
[Drawing 3]



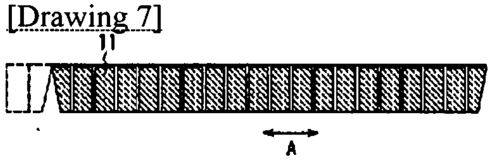
[Drawing 4]



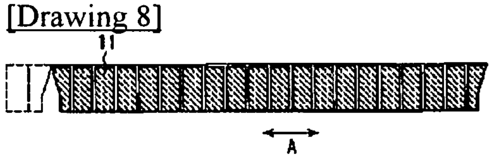
[Drawing 6]



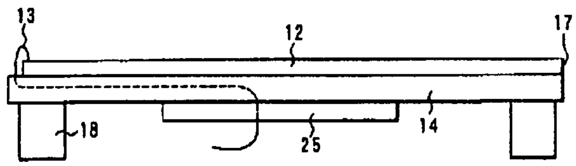
[Drawing 7]



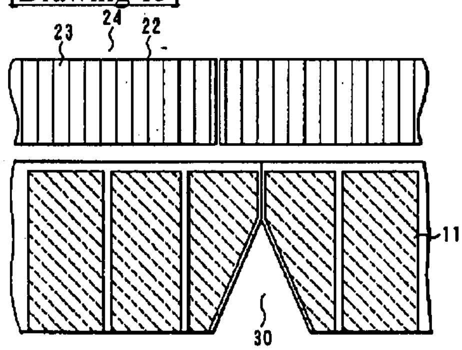
[Drawing 8]



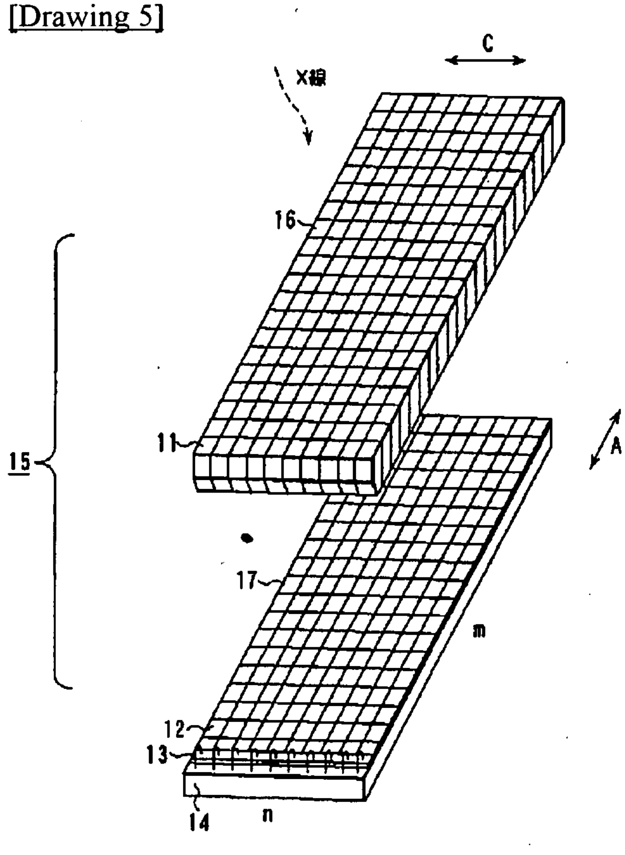
[Drawing 11]



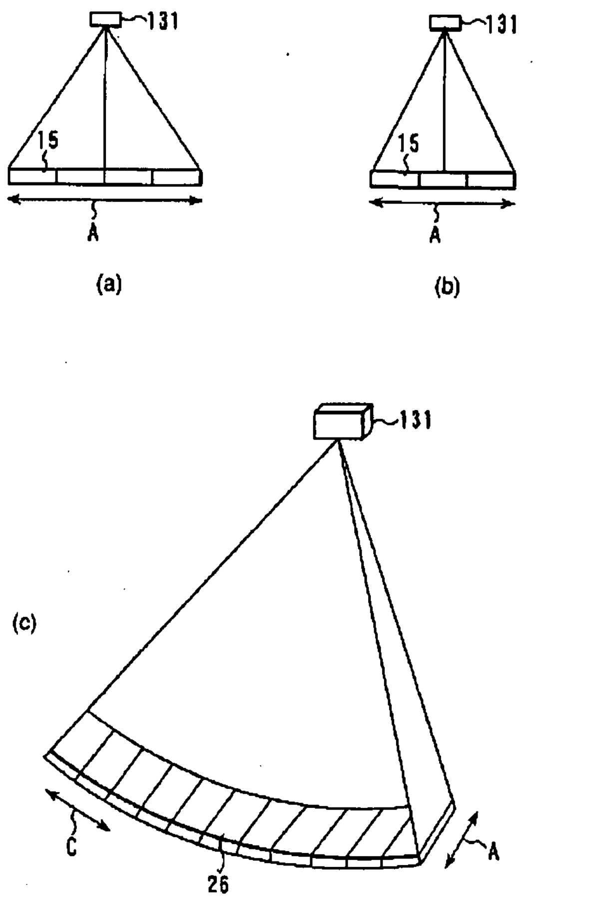
[Drawing 13]



[Drawing 5]

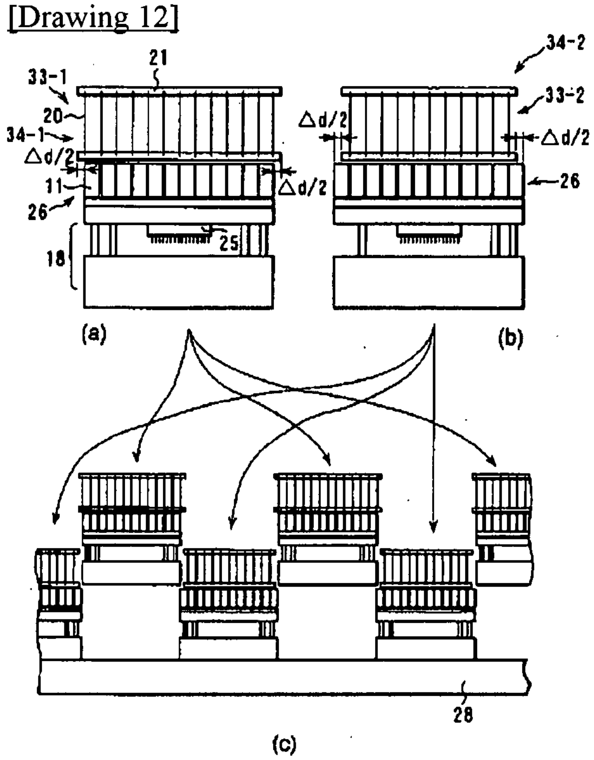


[Drawing 9]



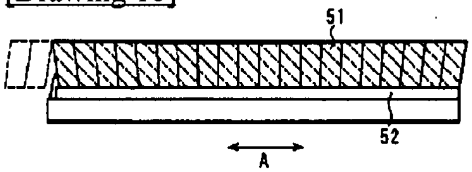
131
15
A
(a)
131
15
A
(b)
131
(c)
C
26
A

[Drawing 12]

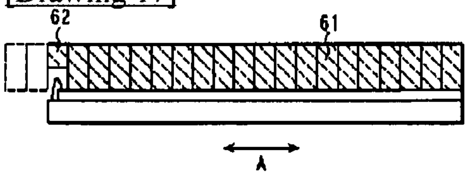


34-2
21
33-1
33-2
20
34-1
△d/2
△d/2
△d/2
△d/2
11
26
26
25
18
(a)
(b)
28
(c)

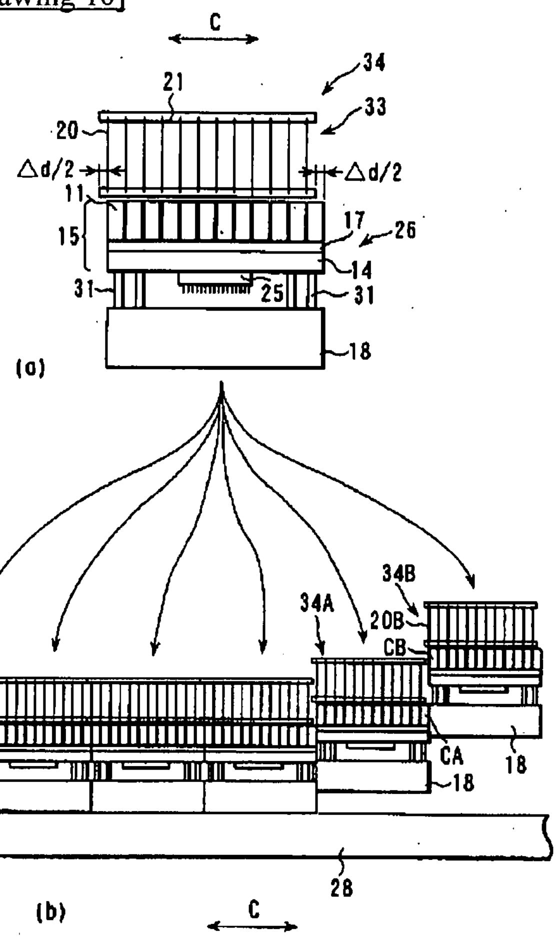
[Drawing 16]



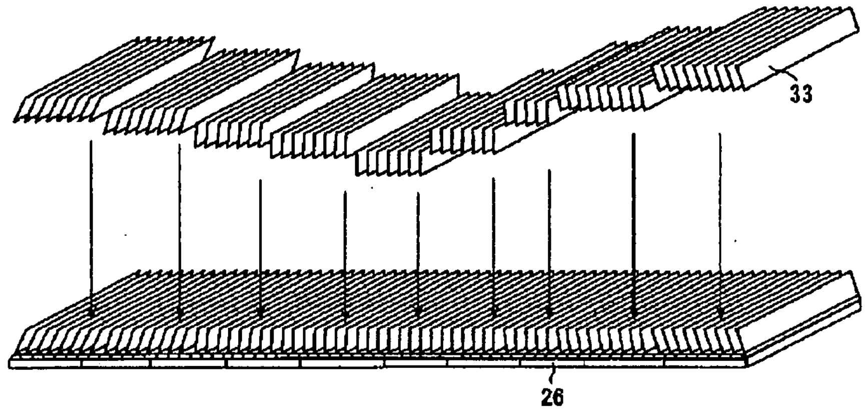
[Drawing 17]



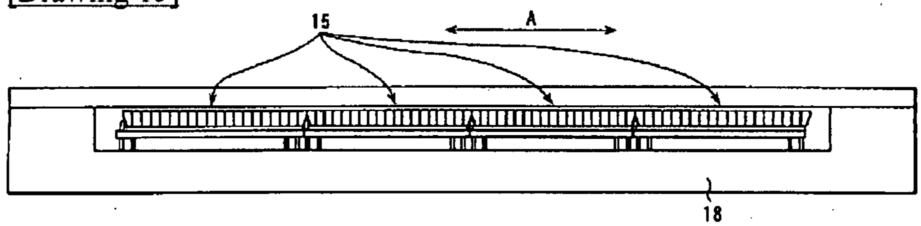
[Drawing 10]



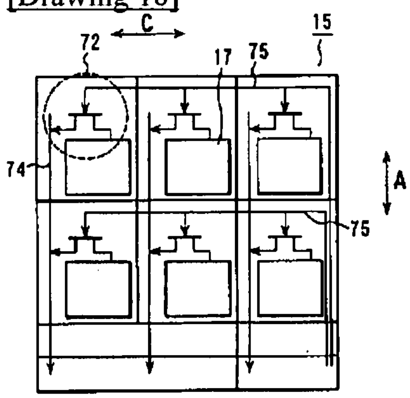
[Drawing 14]



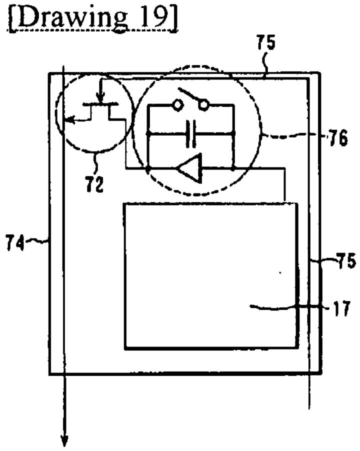
[Drawing 15]



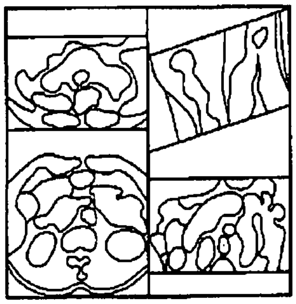
[Drawing 18]



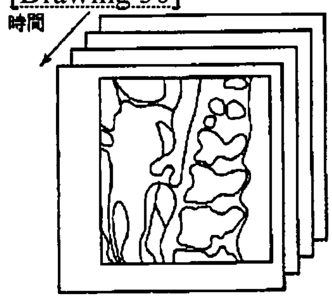
[Drawing 19]



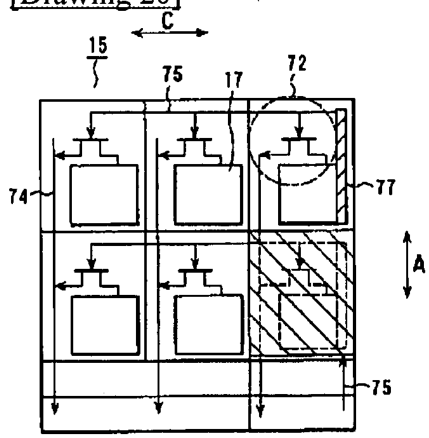
[Drawing 29]



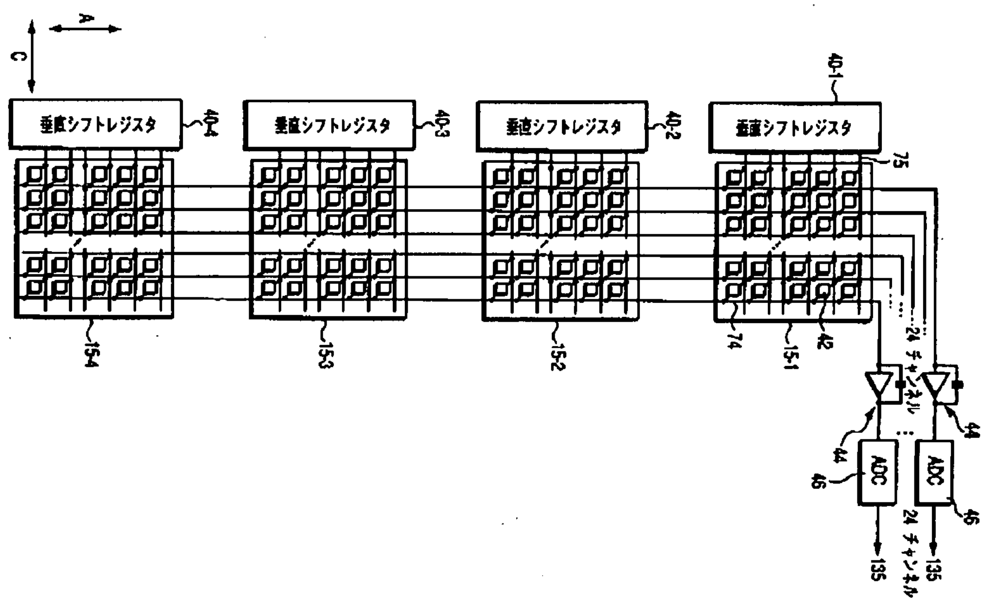
[Drawing 30]



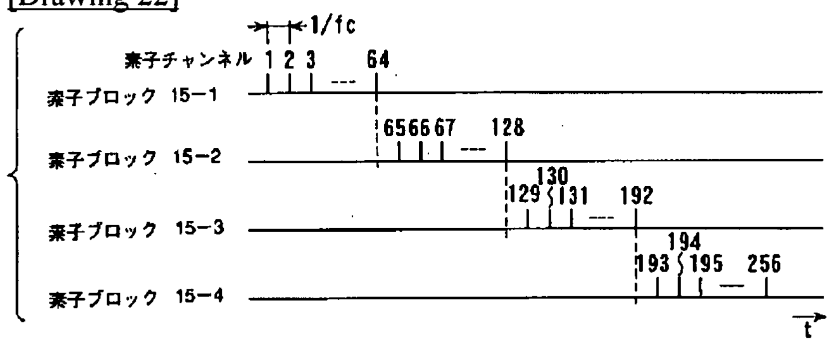
[Drawing 20]



[Drawing 21]



[Drawing 22]



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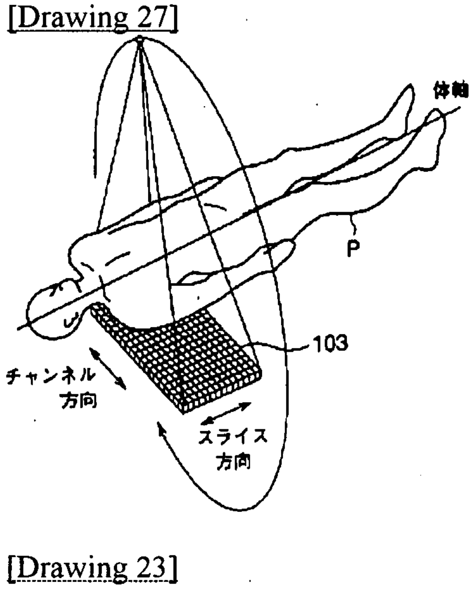
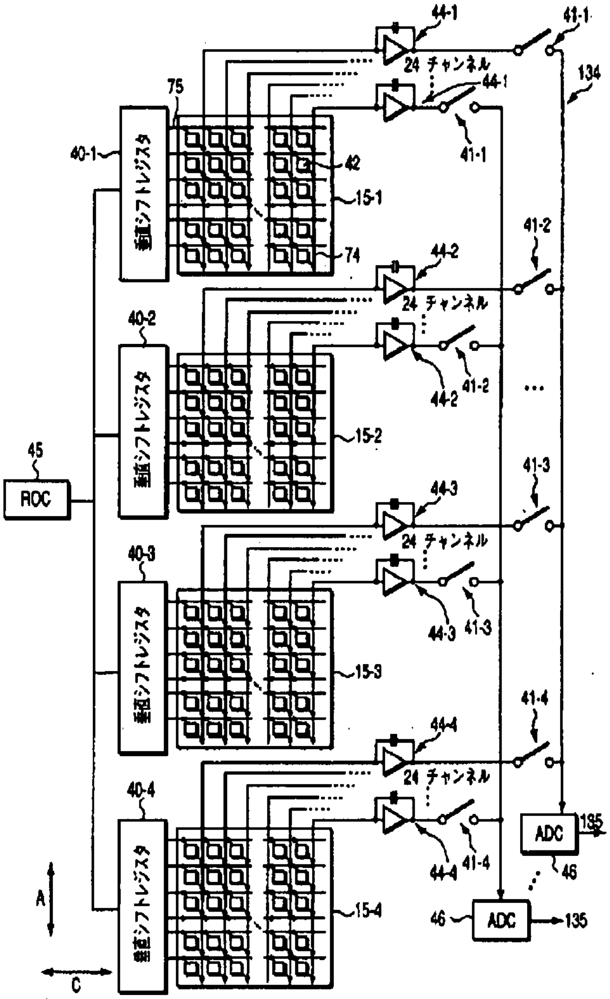
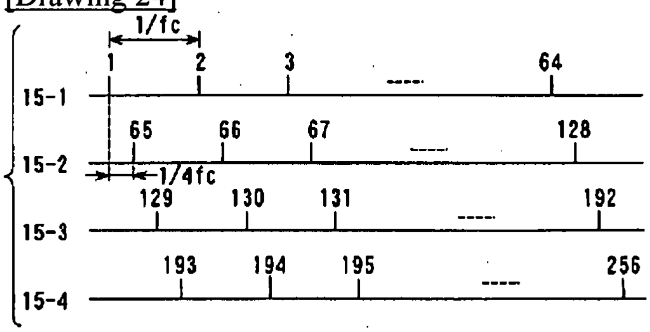


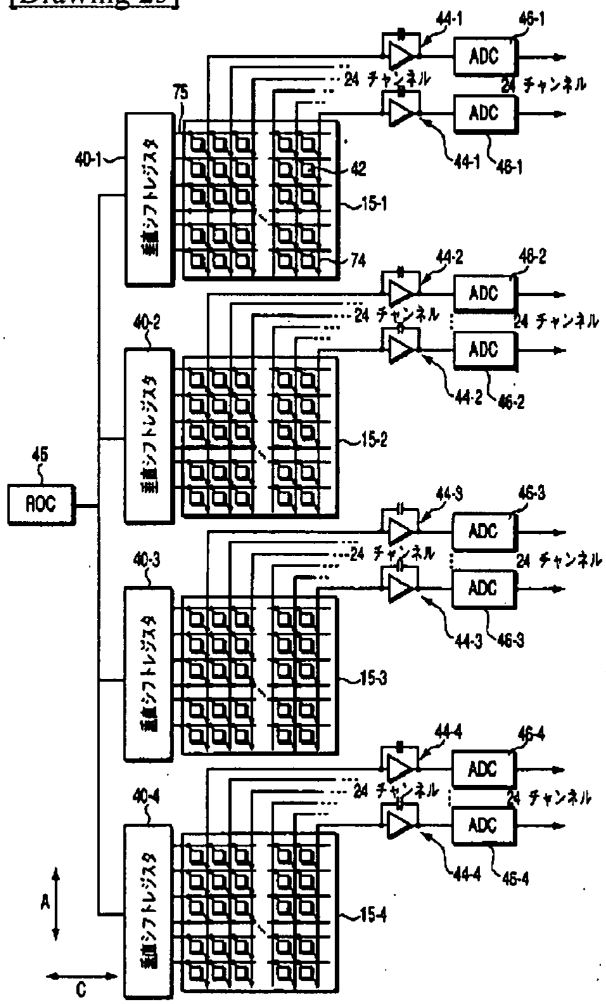
[Drawing 23]


44-1
41-1
24 チャンネル
44-1
134
75
40-1
垂直シフトレジスタ
41-1
42
15-1
74
41-2
44-2
24 チャンネル
40-2
垂直シフトレジスタ
44-2
41-2
15-2
45
ROC
41-3
44-3
24 チャンネル
40-3
垂直シフトレジスタ
44-3
41-3
15-3
41-4
44-4
24 チャンネル
40-4
ADC
135
44-4
41-4
46
A
垂直シフトレジスタ
15-4
46
ADC
135
C

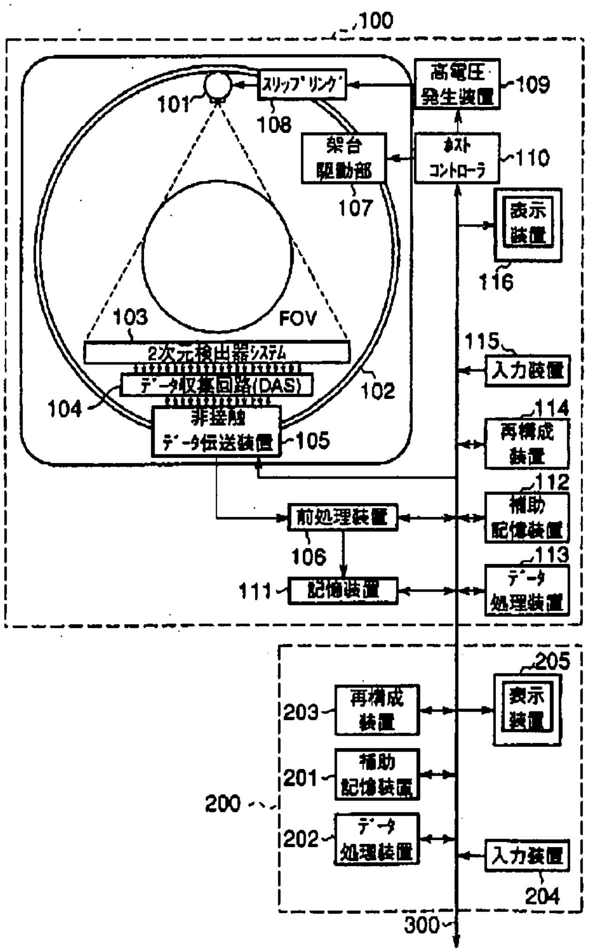
[Drawing 24]


1/fc
1
2
3
64
15-1
65
66
67
128
15-2
1/4fc
129
130
131
192
15-3
193
194
195
256
15-4

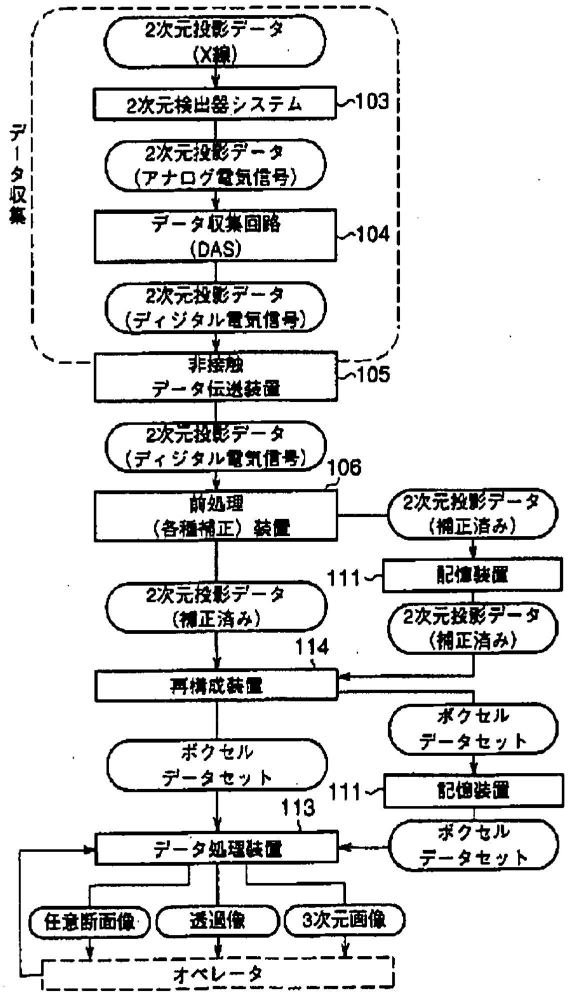
[Drawing 25]



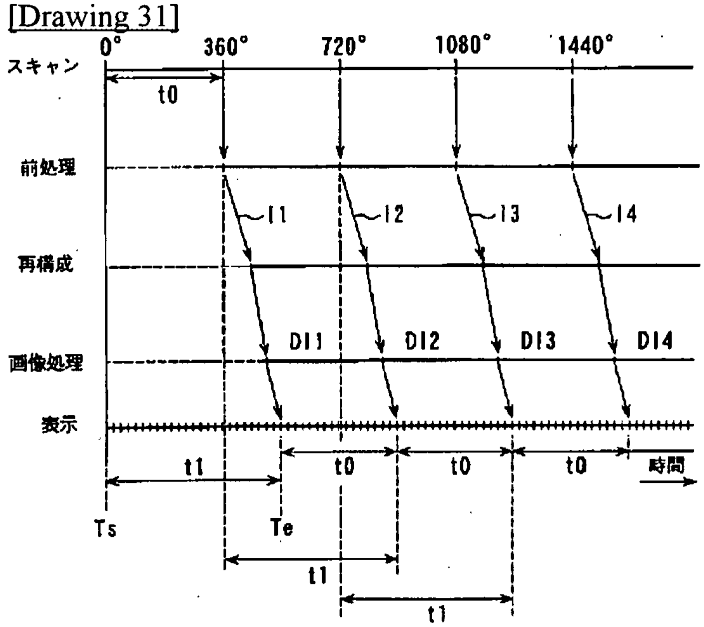
[Drawing 26]


100
高電圧発生装置
109
スリップリング
101
108
架台駆動部
107
ホストコントローラ
110
表示装置
116
103
FOV
2次元検出器システム
データ収集回路(DAS)
102
104
非接触データ伝送装置
105
115
入力装置
114
再構成装置
112
補助記憶装置
113
データ処理装置
前処理装置
106
111
記憶装置
205
表示装置
203
再構成装置
201
補助記憶装置
200
202
データ処理装置
入力装置
204
300

[Drawing 28]


2次元投影データ
(X線)
2次元検出器システム
103
データ収集
2次元投影データ
(アナログ電気信号)
データ収集回路
(DAS)
104
2次元投影データ
(ディジタル電気信号)
非接触
データ伝送装置
105
2次元投影データ
(ディジタル電気信号)
106
前処理
(各種補正)装置
2次元投影データ
(補正済み)
111
記憶装置
2次元投影データ
(補正済み)
2次元投影データ
(補正済み)
114
再構成装置
ボクセル
データセット
ボクセル
データセット
111
記憶装置
ボクセル
データセット
113
データ処理装置
任意断面像
透過像
3次元画像
オペレータ

[Drawing 31]


0°
360°
720°
1080°
1440°
スキャン
t0
前処理
I1
I2
I3
I4
再構成
DI1
DI2
DI3
DI4
画像処理
表示
t1
t0
t0
t0
時間
Ts
Te
t1
t1

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the radiation detector and X-ray CT scanner of a two-dimensional-array mold with which two or more sensing elements which detect radiations, such as an X-ray, as an electrical signal were arranged in the shape of a matrix.
[0002]
[Description of the Prior Art] A medical-application X-ray CT scanner has an X-ray tube and a detector. The X-ray generated with the X-ray tube penetrates analyte, and it carries out incidence to a detector. The detector is equipped with two or more sensing elements which detect radiations, such as an X-ray, as an electrical signal. There is it in a sensing element, the indirect conversion form where change an X-ray into light with fluorescent substances (scintillator etc.), and the light is further changed into an electrical signal by optoelectric transducers (photodiode etc.), and the property of a specific semi-conductor, i.e., the direct conversion form where the generation of an electron-hole pair in a semi-conductor and the migration to the electrode, i.e., a photoconduction phenomenon, were used with the X-ray, and it is thought that the direct conversion form where small, a light weight, and a plate form are realizable spreads from now on.
[0003] The single slice mold detector has spread as a detector for X-ray CT. The single slice mold detector is equipped with two or more sensing elements arranged by the single tier. The poor multi slice mold detector about the same as a double sequence of numbers is also known in this single slice mold detector.
[0004] drawing 1 -- the fragmentary sectional view of the conventional multi-slice mold detector -- drawing 2 -- the flat-surface schematic drawing -- it is shown. In addition, the scintillator is removed in drawing 2 . Two or more photodiodes 92 are arranged at the tooth back of a scintillator 97. Two or more photodiodes 92 are connected to two or more integrators 95 through two or more wires 91, respectively. The selecting switch 96 is formed in each one train of every. Reading appearance of the output of an integrator 95 is carried out to sequence through a selecting switch 96. The output of a selecting switch 96 is electrically connected to the substrate 94 through the bonding wire 93.
[0005] An integrator 95 accumulates the signal detected with the photodiode 92. Moreover, an integral signal is outputted to a substrate 94 through a bonding wire 93 in order by the selecting switch 96. The reason for reading an integral signal in order with a selecting switch 96 is because the number of the bonding wires which can be formed in a substrate 14 is restricted.
[0006] Rather than the above-mentioned multi-slice mold detector, there are many channels and the two-dimensional-array mold detector as lateral (the direction of a channel) it with the almost more nearly same still component pitch of a lengthwise direction (the slice direction) attracts attention as a next-generation detector.
[0007] However, two or more various troubles which must be solved have blocked utilization of this two-dimensional-array mold detector.
[0008] The 1st problem is that the precision of machining which carries out the tile of the component of the many to a specific configuration falls, when the number of sensing elements increases dramatically like a two-dimensional-array mold detector.

[0009] If the number of sensing elements of the problem [2nd] increases dramatically like a two-dimensional-array mold detector, possibility that the sensing element which does not function normally will occur will become high, therefore the yield will fall.
[0010] similarly, if it is used for a long time, it will be alike and it will not be avoided in many sensing elements that the component which does not function normally occurs. In that case, it is necessary to exchange a sensing element array or the whole detector, therefore required costs are not cheap. This is the 3rd problem.
[0011] Moreover, in CT, the signal sampling of a-100 number or the huge count of thousands of times is performed per revolution. Therefore, the time amount allowed for signal read-out of one period is very short. It is dramatically difficult to complete read-out of the signal of very many channels in this short read time. This is the 4th problem.
[0012]
[Problem(s) to be Solved by the Invention] The object of this invention is to offer the radiation detector which realizes tiling of the shape of a matrix of very many sensing elements.
[0013]
[Means for Solving the Problem] It is characterized by for the radiation detector of this invention having two or more arranged component blocks, and said component blocks of each having two or more radiation sensing elements formed by the matrix of mxn on the single substrate.
[0014]
[Embodiment of the Invention] (The 1st operation gestalt) Drawing 3 is the system chart of the X-ray CT scanner in the 1st operation gestalt.
[0015] X-ray tube 131 is supported pivotable in the perimeter of analyte 132 with the radiation detector 127. X-ray tube 131 generates the so-called cone beam X-ray which spreads in the 2-way of the direction C of a channel, and the slice direction A (direction parallel to a revolving shaft (direction vertical to space)). The X-ray which penetrated analyte 132 is detected by the radiation detector 127. The signal detected with this radiation detector 127 is sent to the data processor 135 which performs amendment processing etc. through the data collection circuit 134, and receives predetermined signal processing, and is temporarily memorized by storage 136. The input unit 143 which sends a control signal is connected to the host controller 138 from the control unit 142 which operates the high-voltage transformer assembly 139 which supplies power to X-ray tube 131, the stand actuator 140 of a revolution stand which rotates X-ray tube 131 grade, the reconstruction equipment 137 which reconfigurates data, the display 141 which displays the image reconfigurated by reconstruction equipment 137, and a display 141 for the host controller 138, and the control unit 142.
[0016] The structure of a radiation detector 127 is roughly shown in drawing 4 . A radiation detector 127 consists of plurality 34 arranged along the direction C of a channel, for example, 38 detector modules. In the case of X-ray CT, 38 detector modules 34 are not superficial, and it is arranged on the radii centering on the focus of X-ray tube 131. One detector module 34 consists of one component module 26 and one collimator module 33. Furthermore, the component module 26 consists of plurality 15 arranged along the slice direction A, for example, four component blocks. One component block 15 is equipped with the sensing element of the mxn individual formed in the shape of a matrix with the circumference circuit on the single substrate. In addition, although one

sensing element is treated as one channel here, of course, the sensing element of a neighboring predetermined number may be treated as one channel. The number of channels per block is manufactured in the matrix size of 24x64 with the comparatively good yield on semiconductor device manufacture.

[0017] In a block manufacture phase, the component block 15 is inspected separately and a defective is eliminated. And plurality 15, for example, four component blocks, is arranged along the slice direction A, and they are fixed on the module base (element 18 of drawing 10 (a)). In addition, four connected component blocks 15 are called the component module 26. The collimator module 33 is attached on this component module 26. Thereby, the detector module 34 is completed. Although the component block 15 is fundamentally assembled by decomposition impossible, its ** to which an assembly, a trial, repair, and exchange of a detector are performed not in the component block 15 but in the unit of the detector module 34 is desirable.

[0018] 38 detector modules 34 are arranged on the curved detector base 28 (drawing 10 (a)). Thereby, a radiation detector 127 is completed. These 38 detector modules 34 can be freely detached and attached separately to the detector base 28. This realizes recovering a radiation detector 127 from failure cheaply and promptly by exchanging only the detector module 34 for the normal detector module 34, when one certain detector module 34 starts a malfunction.

[0019] In addition, although a radiation detector 127 may be constituted by arranging the component block 15 in the two directions of Direction A and Direction C which intersect perpendicularly mutually, without using the component module 26, to treat in module 34 unit is more desirable from fields, such as working efficiency and a yield.

[0020] Drawing 5 is the decomposition perspective view of the component block 15, and drawing 6 is a sectional view. The photodiode 17 formed in the front face of a substrate 14 in the shape of a mxn matrix is mounted. The scintillator block 16 is attached on a photodiode 17. The scintillator block 16 consists of scintillator piece 11 of the same mxn individual as the matrix of a photodiode 17.

[0021] The coat of the light reflex material is carried out to the side face and X-ray plane of incidence of the scintillator piece 11. Light reflex material prevents leak of the light generated with each scintillator piece 11 while preventing the incidence of disturbance light. Sticking a white plastic sheet on the side face and X-ray plane of incidence of the scintillator piece 11 may be substituted for the coat of light reflex material.

[0022] As a rectangular parallelepiped and n scintillator piece 11 located in the ends of the slice direction A although it is a cube typically are shown in drawing 6 , the end face cuts aslant inside, scintillator applying [a great portion of / 11] it to a base from near an abbreviation center, it is lacked, and has the cross-section configuration of abbreviation 5 square shape. The bonding wire 13 for connecting a photodiode 17 to a substrate 14 is stored in the tooth space of this notching part 30. In case the fastener of four component blocks 15 is carried out along the slice direction A according to this structure since the component module 28 is constituted as shown in drawing 9 (a) and drawing 9 (b), scintillator piece 11 can be stuck between the component blocks 15, and the gap during a block can be canceled. Moreover, in case the detector module 34 is arranged in the direction C of a channel as shown in drawing 9 (c) since the bonding wire 13 was pulled out from the edge of the slice direction, the gap of an inter module can be canceled.

[0023] In addition, there is especially no limit in the configuration of the notching part

30. For example, as shown in drawing 7 , from a front face, it applies to a base, and the end face of the scintillator piece 11 may be cut aslant, and may be lacked. In this case, the scintillator piece 11 of the edge concerned has a trapezoid cross-section configuration. Moreover, a moderate bow is attached and you may make it cut and lack it, as it is not linear and the end face of the scintillator piece 11 is shown in drawing 8 .

[0024] The surface area of the component block 15 (substrate 14) is designed in general equally to the X-ray plane of incidence of the scintillator block 16. Moreover, the magnitude of the scintillator block 16 is designed in general equally. In addition, the magnitude of the photodiode 17 located in the ends of the slice direction A may be small designed a little from the magnitude of photodiodes 17 other than ends for the joint margin. In this case, although the channel of the edge of the slice direction A of the detector module 34 has the inclination for X-ray conversion rates to differ greatly, compared with things other than an edge, this problem is solvable by performing data correction, such as weighting interpolation, for the data detected by the channel of an edge with a data processor 35. About weight, it sets up in consideration of precision, resolution to expect of the object of inspection, for example, the data of the component of an edge.

[0025] The signal detected with the photodiode 17 is sent to a substrate 14 through a bonding wire 13 as an electrical signal. On the problem on a bonding processing technique, a bonding wire 13 projects to some extent from the front face of a photodiode 12. The projecting bonding wire 13 is stored in the sum total tooth space of the slitting part 30 of two component blocks 15 which adjoin in the slice direction A.

[0026] The side elevation which looked at one detector module 34 from the slice is shown in drawing 10 (a). As mentioned above, one detector module 34 consists of one component module 26 which consists of four component blocks 15 connected in the slice direction, and one collimator module 33 attached on the component module 26. The component module 26 is fixed through the stand 31 for immobilization on the tabular module base 18. In the tooth back of the component module 26, read-out and the data collection circuit board 25 to collect are arranged in the signal from the photodiode 17. As shown in drawing 11 , the signal sent to the substrate 14 through the bonding wire 13 from the photodiode 17 passes along interior wiring of a substrate, and is sent to the circuit board 25 of the data collector 143 arranged at the substrate tooth back. In addition, you may make it form this circuit 25 with a photodiode array and its circumference circuit on the substrate 14 of a photodiode 17.

[0027] The collimator module 33 has two or more collimator plates 20 with a tungsten, heavy molybdenum, etc. and high rigidity. Two or more collimator plates 20 are supported between the collimator supports 21 of two sheets so that it may be arranged by parallel at spacing equal to the pitch of a channel. Location adjustment of the collimator module 33 is carried out to the component module 26 so that two or more collimator plates 20 may be located on the boundary of two or more channels, respectively.

[0028] The width of face of the direction C of a channel of the collimator module 33 is designed equally to the width of face of the component module 26. However, the collimator module 33 is not arranged right above the component module 26, but only one half of the distance (deltad/2) of distance between the central point (pitch) deltad of an adjacent sensing element (channel) is shifted in the direction C of a channel to the component module 26. When only distance (deltad/2) shifted this collimator module 33

to the component module 26, as shown in drawing 10 (b), the collimator plate 20 can be located right above the boundary of the channel of the adjacent component module 26. Thereby, when 38 detector modules 34 are arranged on the detector base 28 at a single tier, also between the channel CA at the right end of certain module 34A, and the channel CB at the left end of module 34B of the right-hand, collimator plate 20B of the left end where module 34B of the right-hand concerned projects is arranged, and the scattered-radiation clearance effectiveness same except an edge is acquired.

[0029] Thus, by arranging the module 34 of the same structure in order in the direction C of a channel, the gap between modules 34 is cancelable.

[0030] As mentioned above, 38 detector modules 34 can be separately removed from the detector base 28 by the comparatively easy activity of removing several screws. Thereby, when one certain detector module 34 starts a malfunction, the module 34 is removed from the detector base 28, and the vacant tooth space is equipped with the normal new module 34. Thereby, a detector 127 can regain a normal function.

[0031] However, since the collimator module 33 has lapped selectively between modules 34 when exchanging a module 34, it cannot remove only the defect module 34 independently, but to also remove two or more normal modules 34 on the right of it with the defect module 34 concerned is needed.

[0032] When exchanging the defect module 34 for the normal module 34, the number of the detector modules 34 to remove is reduced, and the modification for increasing the efficiency of the exchange is shown in drawing 12 (a), drawing 12 (b), and drawing 12 (c). For this reason, two kinds of detector modules 34-1 and 34-2 are prepared. The collimator module 33-1, the width of face of 33-2, and the number of the collimator plates 20 are only different, and, as for two kinds of detector modules 34-1, and 34-2, other structures are the same. As shown in drawing 12 (a), one collimator module 33-1 has more one collimator plates 20 than the number of channels (n), and as the collimator module 33-2 of another side is shown in drawing 12 (b), there are few collimator plates 20 one than the number of channels (n). Only the part of the difference in the number of these collimator plates 20 (two sheets) has the width of face of one collimator module 33-1 longer than the width of face of the collimator module 33-2 of another side.

[0033] Thus, the collimator module 33-1, two kinds of detector modules 34-1 from which 33-2 is different, and 34-2 are arranged without a clearance by turns along the direction C of a channel on the detector base 28, as shown in drawing 12 (c).

[0034] Although the detector module 34 becomes two kinds, when such structure exchanges the defect module 34 for the normal module 34, the number of the detector modules 34 with the need of removing can be reduced to 1 or three pieces. When exchanging the defect module 34 of drawing 12 (a), only the defect module 34 is removed and it equips with the normal module 34. When exchanging the defect module 34 of drawing 12 (b), with the defect module 34, two modules 34 of the neighbors are removed, it equips with the normal module 34, and two neighboring modules 34 are returned.

[0035] In addition, a grid may be used instead of a collimator. The thing using a grid is shown in drawing 13 . In addition, drawing 13 is an enlarged drawing a grid and near scintillator piece. It pastes up and the grid 24 is constituted so that the heavy metallic foils 22, such as lead, may be inserted by turns [the medium material 23 and by turns] which were made from light matter, such as aluminum. Since a metallic foil 22 is

supported by the medium material 23, its support like the collimator support 21 is unnecessary.
[0036] In addition, a collimator arranges the detector module 34 which has not equipped with the collimator module 33, and you may make it equip the detector module 34 with the collimator module 33 after that, as are mentioned above, and you may make it complete in arranging the detector module 34 equipped with the collimator module 33 and it is shown in drawing 14 . Moreover, you may make it attach the collimator which connected the collimator module 33 and was completed in the arranged detector module 34.
[0037] As mentioned above, a large-sized radiation detector without a clearance required for acquisition of the voxel data which continued in time etc. can be created by adding slitting to a part of scintillator piece 11 of an edge, and arranging ejection means, such as a bonding wire 13, to said slitting.
[0038] For example, although only four channels have been arranged in the slice direction A in the conventional example, as shown in drawing 15 , this invention can attain 256 channels of the slice direction by putting in order four component blocks 15 which have the photodiode of m (for example, 64 pieces) in the slice direction A. The number of channels of further many in the increase of the number of arrays or carrying out or arranging [of the component block 15] two or more component modules 26 along the slice direction A is realizable.
[0039] The channel matrix of MxN (256x912) is realizable with the whole detector in arranging the component block 15 equipped with the photodiode of a mxn (64x24) individual in four pieces and the 38 directions C of a channel in the slice direction A. m may be even pieces, m= 64 [for example,], and may be m= 65 odd pieces. In addition, the number of m is not limited. Furthermore, the direction of a channel may also be even pieces, n= 24 [for example,], and odd pieces may be n= 25. In addition, the number of n is not limited like m. Moreover, similarly the number of a detector module is not limited to even number, odd number, etc.
[0040] When the number of the slice direction A of the component block 15 is even, for example, as shown in drawing 9 (b), in moreover, the four cases The center line of the slice direction of an X-ray generated from X-ray tube 131 a part for the joint of the component block 15 and other component blocks A passage, When the number of the slice direction A of the component block 15 is odd, for example, as shown in drawing 9 (c), the center line of the slice direction of an X-ray generated from X-ray tube 131 will pass along the core of the component block 15 three cases.
[0041] In addition, in ****, although scintillator piece considered as the rectangular parallelepiped, as shown in drawing 16 , it may adopt the scintillator piece 51 of a cross-section abbreviation parallelogram with the top chord slightly longer than the lower side which is an optical output side side which is an X-ray plane-of-incidence side, and may adopt the scintillator piece of a cross-section trapezoid to which the optical output side becomes narrow rather than X-ray plane of incidence. Moreover, a photodiode 52 is made into the optical output side of the scintillator piece 51, a location which counters, and a configuration. Since it is the same as that of the 1st operation gestalt, other configurations are omitted.
[0042] in this case, the optical ON slant face of the photodiode which has joined the optical plane of incidence of the photodiode joined to the scintillator piece of scintillator

block ends to scintillator piece other than ends although the manufacture approach of a scintillator block becomes complicated since any scintillators other than ends are also no longer a rectangular parallelepiped and abbreviation -- since it can consider as the same magnitude, the data precision detected at both ends can be improved. Moreover, it is good also as a configuration where the optical output side is narrower than the X-ray plane of incidence of the scintillator piece which chose and chose two or more scintillator piece from the edge.

[0043] In this case, if said data processor 35 performs data correction, such as weighting interpolation, also to the data detected with the whole scintillator-photodiode since scintillators other than the ends of a component block and the configuration of a photodiode change, and X-ray conversion rates may differ greatly, data precision can be improved more. About weight, it sets up in consideration of precision, resolution to expect of the object of inspection, for example, the data of the component of an edge.

[0044] moreover, it is shown in drawing 17 -- as -- the scintillator piece 61 of an edge -- **** -- the same -- X-ray plane of incidence and an optical output side -- abbreviation -- although it is the configuration of the abbreviation rectangular parallelepiped of the same magnitude, the dummy scintillator 62 thinner than others is formed. the magnitude of the X-ray plane of incidence of the dummy scintillator 62 -- the X-ray plane of incidence of the scintillator piece 61, and abbreviation -- it is the same magnitude and the die length of a side face consists of die length of the scintillator piece 61 short. The dummy scintillator 62 is a thing aiming at electric shielding of an X-ray etc., and what shaded the usual scintillator, the thing which changed the configuration so that light might not be emitted with the almost same configuration, or a heavy metal is used for it so that an X-ray may be irradiated by the bonding wire 13 and incorrect actuation may not be caused. In addition, the installation location of the dummy scintillator 62 is performed so that the X-ray plane of incidence of said scintillator piece 61 and dummy scintillator 62 may serve as abbreviation flatness.

[0045] Moreover, you may make it make it in agreement with the die length of the scintillator block 16 about the direction of a channel of the dummy scintillator 62. In this case, although the die length of a side face is not different from the above-mentioned thing, the magnitude of the X-ray plane of incidence of the dummy scintillator 62 is equal to the slice lay length of said scintillator piece 61 in the slice direction, and serves as the die length of said scintillator block 16 in the direction of a channel.

[0046] in this case, the configuration of each scintillator and a photodiode -- abbreviation -- since it becomes the same magnitude -- each scintillator and the X-ray conversion rate of a photodiode -- abbreviation -- although it is the same in many cases, since the photodiode is not used, to the dummy scintillator 62, the dummy scintillator 62 cannot acquire data. Therefore, in case two or more component blocks 15 are arranged in the slice direction A, the lack part of data will exist between component blocks. Then, to missing data, it is the approach which has asked for the weighting average value enough the photodiode which adjoins in the slice direction A of a lack part, or the photodiode which adjoins further, and makes it it from the data acquired with the photodiode which adjoins in the direction C of a channel, and data precision can be improved more by performing amendment used as the data of a lack part. About the range of the data used for interpolation, and weight, it sets up in consideration of precision, resolution to expect of the object of inspection, for example, the data of the component of an edge.

[0047] Thus, the approach using a dummy scintillator can be enforced only by adding an electric shielding means to the conventional scintillation block, and is very high. [of application]
[0048] Drawing 18 shows some circuit diagrams of the component block 15. The component block 15 is equipped with two or more photodiodes 17 arranged by the matrix of mxn. The signal line 74 is connected to the output of two or more photodiodes 17 respectively through two or more transistor switches 72. Common connection of the output of m photodiodes 17 arranged by the single tier in the slice direction A is made at the same signal line 74. Moreover, common connection of the gate of n switches 72 arranged in the direction C of a channel is made at the same control line 75.
[0049] If an X-ray carries out incidence to a certain scintillator piece 11, an X-ray will be changed into light with the scintillator piece 11. The light is changed into an electrical signal with the corresponding photodiode 17. In a photodiode 17, the period when a switch 72 is off, and a charge are accumulated. Two or more control lines 75 are activated in order. Synchronizing with this, two or more switches 72 are turned on in order. that is, two or more control lines 75 -- a switch 74 -- the slice direction -- sequence -- and in the direction of a channel, it is turned on at parallel. Thereby, reading appearance of the charge information on two or more slices is carried out serially. At the former, although each photodiodes of each were wired in one signal line, a signal-line number can be substantially decreased by communalizing a signal line with two or more photodiodes located in a line in the slice direction for every channel.
[0050] In addition, when it constitutes one slice from a photodiode of a neighboring predetermined number, signal addition can be realized in analog by switching [72] off the neighboring control line 75 all at once. The data bundled in the slice direction by this can be outputted.
[0051] Other configurations of a part of component block 15 are shown in drawing 19 . An integrator 76 intervenes between a photodiode 17 and a switch 72. The type whose integrator 76 connected the amplifier and the capacitor to juxtaposition, or other types are adopted.
[0052] Since the output of a photodiode is the current signal of an analog, in order that it may usually perform signal processing in a computer, first, it transforms this current signal into a voltage signal, and changes a voltage signal into a digital signal. In the example of drawing 19 , a current / electrical-potential-difference conversion is performed by the integrator 76 formed between the photodiode 17 and the switch 72. Thereby, it is not necessary to prepare a current / electrical-potential-difference conversion circuit in the data collection circuit board 25. Moreover, a speed of response improves. Furthermore, since the path of the output of the latter part of the amplifier of an integrator 76 becomes long relatively and the path of the amplifier preceding paragraph of being easy to be influenced of disturbance, such as a noise, becomes short, it is hard coming to win popularity the effect of disturbance, such as a noise.
[0053] Moreover, as shown in drawing 20 , the control signal generating circuit 77 is established in the corner of the component block 15. Although the scintillator which exists in the direction of space is omitted in drawing 20 , in order to explain the physical relationship of the component of a scintillator and others, only one part is filled in with the slash. Moreover, a switch 72 and the control signal generating circuit 77 are arranged so that it may see from X-ray tube 131 and may become the shadow of a scintillator, and

it is made not to receive malfunction or the damage by the exposure of an X-ray. Thus, since what is necessary is just for there to be no need of forming two or more wiring which supplies a control signal in two or more control lines 75 from the outside of a component block, and to supply several control signals to the control signal generating circuit 77 from the exterior of a component block by having established the control signal generating circuit 77 in the corner of the component block 15, wiring can be constituted simply.

[0054] Next, the signal read-out operation by 1 operation gestalt of this invention is explained. Drawing 21 is attained to with one detector module of a detector 127, and the rough circuit diagram of the data collection circuit 134 of the part corresponding to one module is shown in it. As mentioned above, one detector module 34 has four component blocks 15-1 arranged in the slice direction, 15-2, 15-3, and 15-4. In addition, two or more sensing elements 42 which consist of scintillator piece 11 and a photodiode 17 explain the component block 15-1, 15-2, 15-3, and 15-4 each here as a thing assumption arranged in the matrix size of 24x64.

[0055] In the component block 15-1, 15-2, 15-3, and 15-4 each, 24 signal lines 74 and the 64 control lines 75 are wired in all directions, and a sensing element 42 is arranged at each of that intersection, respectively. The output of the photodiode 17 of 64 sensing elements 42 arranged in the slice direction A of the same channel is connected to the common signal line 74 respectively through 64 component transistor switches (not shown). This signal line 74 is between component blocks, and each other is connected. 24 signal lines 74 are connected to amplifier 44, respectively. On the other hand, common connection of the gate of 24 component transistor switches arranged in the direction C of a channel of the same slice is made at 64 control-lines 75 each.

[0056] A pulse is turned on in order by the 64x4 control lines 75 covering the vertical shift register 40-1 of each block, 40-2, 40-3, and 40-four to four component blocks 15-1, 15-2, 15-3, and 15-4. As this shows drawing 22 , reading appearance of the signal of 64x4 sensing elements 42 arranged in the direction of a channel of the same slice is carried out to sequence at an amplifier 44, it is changed into a voltage signal, and is further changed into a digital signal with the analog-to-digital-conversion machine (ADC) 46. Even the 24th signal line 74 has such parallel actuation from the 1st signal line 74, and it is performed simultaneously. To 38 detector modules 34, it is parallel and signal read-out operation in still such a detector module 34 is performed simultaneously.

[0057] Other configurations of the detector module 34 are shown in drawing 23 . In this example, a signal line 74 is between component blocks, and is not connected, but an output line 47-1, 47-2, 47-3, 47-4, amplifier 44-1, 44-2, 44-3, and 44-4 are separately prepared to the component block 15-1, 15-2, 15-3, and 15-4. The output of an amplifier 44-1, 44-2, 44-3, and 44-4 is outputted through the common analog-to-digital converter 46.

[0058] One fourth of a data collection period (1/fc) is shifted time amount every, and the switch 41--1 of these four amplifier 44-1, 44-2, 44-3, and 44-4, 41-2, 41-3, and 41-4 are opened and closed in order. As this shows drawing 24 , signal read-out is performed according to an interleave method. That is, signal read-out of the photodiode 17 of other three component blocks 15-2, 15-3, and 15-4 is wedged next between signal read-out of the photodiode 17 of the next door of the slice direction A with signal read-out of the photodiode 17 with the component block 15-1. According to this method, high-speed

read-out is realized.
[0059] Furthermore, as shown in drawing 25 , an analog-to-digital converter 46-1, 46-2, 46-3, and 46-4 are separately prepared to the component block 15-1, 15-2, 15-3, and 15-4, and it may be made to perform signal read-out from four component blocks 15-1 in one module 34, 15-2, 15-3, and 15-4 to parallel.
[0060] (The 2nd operation gestalt) This operation gestalt is related with the X-ray CT scanner (X-ray computed tomography equipment; CT scanner) equipped with the radiation detector of the two-dimensional-array mold of the large visual field of the 1st operation gestalt. In addition, the revolution/revolution whose X-ray tube and radiation detector rotate the perimeter of analyte as one body to an X-ray CT scanner (ROTATE/ROTATE) A type, and the immobilization/revolution only whose X-ray tube the array of many sensing elements is carried out to the shape of a ring, and rotates the perimeter of analyte (STATIONARY/ROTATE) There are various types, such as a type, and this invention can be applied by any type. Here, it explains as a revolution/revolution type which occupies current and the mainstream. moreover -- for reconfigurating the voxel data (or tomogram for one sheet) of 1 volume -- 1 round of perimeters of analyte, and the projection data for about 360 degrees -- moreover, the projection data for about 210-240 degree is needed also for the half scanning. This invention is applicable to any method. Here, it explains as what reconfigurates the voxel data (or tomogram for one sheet) of 1 volume from the projection data for about 360 degrees of the general former.
[0061] The configuration of the X-ray CT scanner applied to this operation gestalt at drawing 26 is shown. The perspective view of the radiation detector of drawing 26 is shown in drawing 27 . The revolution ring 102 is driven by the high-speed revolution of 1 or less second per revolution by the stand actuator 107. X-ray tube 101 for generating a cone beam (rectangular-head drill)-like X-ray to the analyte P laid in the effective visual field field FOV is attached in this revolution ring 102. Power required for the exposure of an X-ray is supplied to X-ray tube 101 through the slip ring 108 from a high-voltage transformer assembly 109.
[0062] The radiation detector 103 for detecting the X-ray which penetrated Analyte P is attached in the revolution ring 102 with the sense which counters X-ray tube 101. Two or more sensing elements constituted from combination of scintillator piece and a photodiode by it as the 1st operation gestalt explained to the radiation detector 103 are arranged in the shape of a matrix about the direction of a channel which intersects perpendicularly with the slice direction of analyte, and it. For example, thousands of sensing elements are arranged about the direction of a channel, and, on the other hand, hundreds of sensing elements are arranged by high density about the slice direction.
[0063] A vast quantity of data (the data for a MxN channel per 1 BIE are called "two-dimensional projection data" below) about all the channels of MxN detected with the radiation detector 103 are once brought together in the data collection circuit (DAS) 104, and are transmitted to the data processing unit of a fixed side through the non-contact data transmission unit 105 to which optical communication was applied collectively. the detection actuation by the radiation detector 103 -- between 1 revolutions (about 1 second) -- for example, it is repeated about 1,000 times and a vast quantity of two-dimensional projection data for a MxN channel is generated per 1,000 times for 1 second (one revolution) by that cause, and in order to transmit the such two-dimensional projection data which it is huge and moreover generates at a high speed without a time

lag, as for the data collection circuit 104 and the non-contact data transmission unit 105, ultra high-speed processing-ization is attained.

[0064] The pre-treatment equipment 106 with which a data processing unit pretreats data correction etc. centering on the host controller 110, a store 111, an auxiliary storage unit 112, a data processor 113, reconstruction equipment 114, the input device 115, and the indicating equipment 116 interconnect through data / control bus 300. Furthermore, the image processing system 200 of the exterior which consists of an auxiliary storage unit 201, a data processor 202, reconstruction equipment 203, an input unit 204, and a display 205 is connected through this bus 300.

[0065] Processing of data and its flow are shown in drawing 28 . After the X-ray which penetrated analyte is changed into the two-dimensional projection data of an analog electrical signal in a radiation detector 103 and is further changed into the two-dimensional projection data of a digital electrical signal in the data collection circuit 104, it is sent to the pre-treatment equipment 106 which performs various amendments through the non-contact data transmission unit 105. Correction by sensitiveness, X-ray intensity amendment, etc. with a pre-treatment equipment 106 a part for 360 degrees of carrier beams, i.e., 1,000-set two-dimensional projection data Once direct or storage 111 memorizes, it is sent to reconstruction equipment 114. For example, reconstruction by the three-dimension image reconstruction algorithm represented by the approach called the Feldkamp method is performed. It is reconfigurated by the three-dimension-distribution data (henceforth "volume data (meeting of voxel data)") of the number of X-ray absorbent system in an object domain (volume) large in the slice direction. Typically, this three-dimension-distribution data is reconfigurated as a meeting of the fault image data of a multi-slice.

[0066] Once the reconfigurated volume data are memorized by direct or the store 111, they are sent to a data processor 113, and are changed into the so-called false three-dimension image data, such as a tomogram for an arbitration cross section, a projection image from arbitration, and a three-dimension surface image of the specific organ by rendering processing, based on directions of an operator, and are displayed on a display 116.

[0067] Although it is common to be carried out by dropping off X-ray CT scanner 100, in the external image processing system 200, it may be made to perform data processing and display operation, such as reconstruction and cross-section conversion. When using the external image processing system 200, the data sent to an image processing system 200 do not bar the effectiveness of this operation gestalt in the state of any just before the display before reconstruction and after reconstruction or data processing from X-ray CT scanner 100.

[0068] Although the voxel size of the above-mentioned volume data changes with one sensing element size of a radiation detector 103, the geometry of a system, data collection rates, etc., it is min and has attained about 0.5mmx0.5mmx0.5mm, for example. And since big volume data can be obtained by one revolution by adopting the radiation detector of the 1st operation gestalt, the voxel data of bearing nature (isotropic), such as a large area, are continuously collectable. Therefore, since abbreviation etc. can spread and carry out resolution of the tomogram for an arbitration cross section, it can profit on clinical.

[0069] The operator of a system chooses and sets up a display gestalt according to the

object of inspection and a diagnosis out of the tomogram for an arbitration cross section above already used widely, the projection image from arbitration, a three-dimension surface display, etc. The image in a different gestalt is generated and displayed from one volume data. It had one kind of not only image but the mode which displays two or more kinds of images simultaneously, and in the case of a display, a change in the mode which displays one image according to the object is possible, and it has come at it.
[0070] The tomogram for an arbitration cross section is a tomogram about the cross section which intersects perpendicularly with the axial side not only of the cross section (axial cross section) which intersected perpendicularly with the body axis acquired with the conventional X-ray CT scanner but a sagittal side and a coronal side, and the OBURIKU cross section to which it inclined to these cross sections further, as shown in drawing 29 . From the above-mentioned volume data, the voxel data of the thickness specified too are extracted, bundled and displayed about the specified cross section. The projection image from arbitration displays maximum, an integrated value, etc. as a two-dimensional image to volume data about the voxel data located in a line in the set-up direction. A three-dimension surface display extracts the front face by the set-up threshold, for example, by shading by the set-up light source, it is the approach of displaying a front face in three dimension, and it is observing changing a threshold and internal structure can also grasp it.
[0071] In the scan of 1 revolution, it can ask for one volume data without time difference in the slice direction in the slice direction about the large object domain of 30cm by performing the above-mentioned data processing from the two-dimensional projection data from [which was acquired only by one revolution] many. Also except an axial cross section, it becomes possible to observe the tomogram in a certain time of day.
[0072] In a continuation revolution scan, in repeating the same processing as the case of 1 revolution and performing it to the two-dimensional projection data from [which was acquired by two or more revolutions] many, the volume data obtained serve as plurality instead of one. Even when reconfigurating for every revolution, the set of the same number as the number of revolutions is obtained, and more volume data which are different little by little in time are obtained by ZURA [the range of the data used for reconstruction (the range of angle of rotation of a system)] little by little.
[0073] About the gestalt of a display image, it is the same as that of the case of 1 revolution, and is selectable according to setting out of the operator of a system out of the tomogram for an arbitration cross section, the projection image from arbitration, a three-dimension surface display, etc.
[0074] From volume data which are different little by little on the above-mentioned time amount target, an image in the set-up gestalt which is different little by little in time is generated, and as shown in drawing 30 , it displays in order. Thereby, an operator becomes possible [observing the image in the set-up gestalt on real time as an animation]. The operation which displays an image as an animation in parallel to this continuation scan is called CT fluoroscopy here.
[0075] One time scale shows the time flow from the scan in this CT fluoroscopy to image display to drawing 31 . Although the include-angle range here required to reconfigurate one three-dimension image data of projection data is explained as 360 degrees, of course, you may be 180 degree+ view angle. First, X-ray tube 101 carries out a continuation revolution for the perimeter of analyte to a high speed with a radiation detector 103. The

time amount which per revolution takes is t0. The projection data collected one after another receives pretreatment in the real time mostly. And with reconstruction equipment 114, three-dimension image data "I" is reconfigurated based on the pretreated projection data for 360 degrees. And based on the reconfigurated three-dimension image data "I", image data "DI", such as a tomogram for an arbitration cross section, a projection image from arbitration, and a three-dimension surface image, is generated with a data processor 113. This image data "DI" is displayed on a display 116.
[0076] By CT fluoroscopy, while a series of processings from these scans to image display are performed in parallel and carry out a continuation scan by this, the image was reconfigurated one after another on that spot, and what is displayed as an animation is realized by displaying it one after another.
[0077] In order to realize this CT projection, it is a short time from the time amount t0 taken for reconstruction equipment 114 to collect the projection data for the predetermined include-angle range (here 360 degrees) in parallel to the collection operation (scan) of projection data, and it has the throughput required in order to reconfigurate three-dimension image data I. Moreover, the data processor 113 is equipped with the throughput required since it is a short time and the display-image data DI are generated from three-dimension image data rather than the reconstruction time amount of three-dimension image data I. Furthermore, the indicating equipment 116 has equipped a counter, memory, etc. required in order to carry out display initiation of the image data DI after fixed time amount from Origin Ts or the terminal point Te of a period of projection data of collection operation. [of the image data DI] [of the origin]
[0078] Furthermore, this equipment is equipped with the following means for making image observation as an animation easy.
(1) Not only right order but a reverse order (rewinding playback) is possible for the sequence of a display.
(2) The renewal of an image (switch of an image) is selectable in renewal of automatic, and renewal of hand control, and a change in the middle of a display is also possible for it.
(3) By renewal of automatic, an operator specifies a start point (animation playback origin) and an ending point (animation playback terminal point), and it is updated with the update rate (image switch rate (reproduction speed of an animation)) beforehand set up within the period.
(i) A start point and an ending point can be changed also in the middle of a display.
(ii) The update rate set up beforehand is equipped with the following modes.
(a) the actual (time interval b) slow (display c) coma delivery (display d) high-speed (X) display (iii) based on the rate of a scan, and reconstruction spacing -- display at the rate of the arbitration which the operator set up even except having been prepared beforehand.
(iv) An update rate is changed also in the middle of a display.
(v) If it displays to an ending point, it will return to a start point and a display will be repeated.
(4) Update in renewal of hand control according to actuation of an operator.
Moreover, in order to make easy grasp of the relation between a motion of the whole and an image on display, it enables the image of Maine to display all or some images simultaneously as an index image about the whole time amount range independently.
(1) It is possible for the time of day of the image of Maine to be displayed, to set up the

time of day of the Maine image on an index image on an index image, and to switch the playback origin of an animation.
(2) An index image is reduced in a data processor 113, or resolution is dropped, it is obtained, and two or more index images are simultaneously displayed on one screen by list.
(3) An index image is generated and displayed for [not all] images, but out of two or more images within the playback period concerned, is thinned out suitably and chosen.
(i) It thins out and displays with a fixed time interval.
(ii) The intense part of fluctuation between images is extracted and displayed.
(4) An index image is also updated as an index image displays the time zone before and behind the Maine image and the Maine image is updated.
Together with the image display of Maine, the CT valve of ROI, an electrocardiogram, etc. display in a graph the information which changes in time, and the time of day of the Maine image on display on a graph also displays.
[0079] (Modification) This invention is not limited to the operation gestalt mentioned above, and in the range which does not deviate from the summary, it deforms variously and it can be carried out at an execution phase. Furthermore, various phases are included in the above-mentioned operation gestalt, and various invention may be extracted by the proper combination in two or more requirements for a configuration indicated. For example, some requirements for a configuration may be deleted from all the requirements for a configuration shown in an operation gestalt.
[0080]
[Effect of the Invention] According to this invention, the radiation detector which realizes tiling of the shape of a matrix of very many sensing elements can be offered.